UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session 2009/2010

November 2009

EBS 238/3 - Fluid Mechanics
[Mekanik Bendalir]

Duration : 3 hours
[Masa : 3 jam]

Please ensure that this examination paper contains THIRTEEN printed pages and TWO pages APPENDIX before you begin the examination.
[Sila pastikan bahawa kertas peperiksaan ini mengandungi TIGA BELAS muka surat beserta DUA muka surat LAMPIRAN yang bercetak sebelum anda memulakan peperiksaan ini.]

This paper consists of SEVEN questions. FOUR question in PART A and THREE questions in PART B.
[Kertas soalan ini mengandungi TUJUH soalan. EMPAT soalan di BAHAGIAN A dan TIGA soalan di BAHAGIAN B.]

Instruction: Answer **FIVE** questions. Answer **TWO** questions from PART A, **TWO** questions from PART B and **ONE** question from any parts. If candidate answers more than five questions only the first five questions answered in the answer script would be examined.
*[**Arahan**: Jawab **LIMA** soalan. Jawab **DUA** soalan dari BAHAGIAN A, **DUA** soalan dari BAHAGIAN B dan **SATU** soalan dari mana-mana bahagian. Jika calon menjawab lebih daripada lima soalan hanya lima soalan pertama mengikut susunan dalam skrip jawapan akan diberi markah.]*

The answers to all questions must start on a new page.
[Mulakan jawapan anda untuk semua soalan pada muka surat yang baru.]

You may answer a question either in Bahasa Malaysia or in English.
[Anda dibenarkan menjawab soalan sama ada dalam Bahasa Malaysia atau Bahasa Inggeris.]

…2/-

PART A

BAHAGIAN A

1. [a] What is metacentric height? What is center of buoyancy? Explain using appropriate figure/s. How are we suppose to determine whether a floating body is stable or not stable.

Apakah tinggi metacentrik? Apakah pusat pengapungan? Jelaskan maksud keduanya dengan bantuan rajah. Bagaimana kita boleh tentukan suatu jasad terapung itu stabil atau tidak?

(25 marks/*markah*)

[b] A brass weight is attached to the bottom of the cylinder described in Figure 1, so that the cylinder will be completely submerged and neutrally buoyant in water at 95°C. The brass is to be a cylinder with the same diameter as the original cylinder shown in Figure 1. What is the required thickness of the brass?
(γ_{water} at 95°C = 9.44kN/m^3)

Sebuah pemberat loyang diikat pada bahagian bawah satu silinder seperti yang ditunjukkan dalam Rajah 1, supaya silinder berkenaan tenggelam sepenuhnya dan terapung secara neutral pada air bersuhu 95°C. Loyang berkenaan mempunyai diameter yang sama dengan silinder asal seperti yang ditunjukkan dalam Rajah 1. Berapakah tebal loyang yang diperlukan untuk silinder berkenaan terapung neutral dan tengelam sepenuhnya?
(γ_{air} pada 95^{0}C = 9.44kN/m^3)

(40 marks/*markah*)

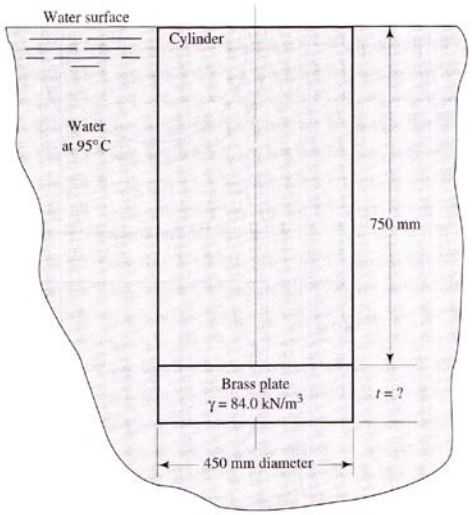

Figure 1

Rajah 1

[c] Figure shows a gate hinged at its bottom and held by a simple support at its top. The gate separates two fluids. Compute the net force on the gate due to the fluid on each side. Then compute the force on the hinge and on the support.

Rajah 2 menunjukkan pintu diengselkan pada bahagian bawah dan disokong oleh satu penyokong mudah dibahagian atas. Pintu tersebut memisahkan kedua-dua bendalir berkenaan. Kirakan daya bersih pada pintu berkenaan disebabkan oleh bendalir pada di kedua-dua belah pintu. Kemudian kirakan daya pada engsel dan pada penyokong.

(35 marks/*markah*)

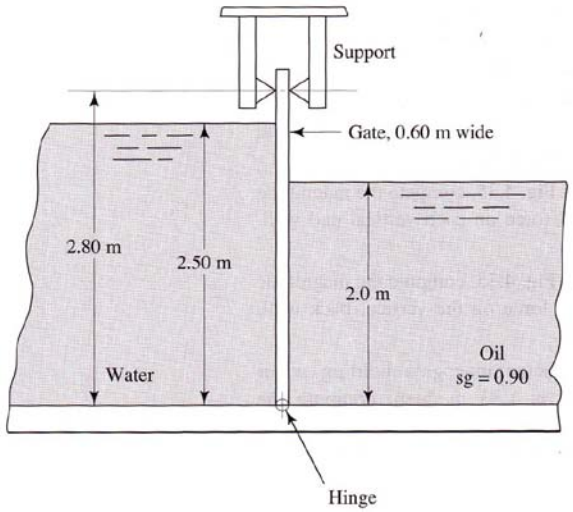

Figure 2

Rajah 2

2. [a] The pump shown in Figure 3 is delivering hydraulic oil with a specific gravity of 0.85 at rate of 75 L/min. The pressure at A is -20 kPa and the pressure at B is 275 kPa. The energy loss in the system is 2.5 times the velocity head in the discharge pipe. Calculate the power delivered by the pump to the oil.

Sebuah pam ditunjukkan dalam Rajah 3 mengalirkan minyak hidraulik yang mempunyai graviti spesifik 0.85, pada kadar 75 L/min. Tekanan pada A ialah -20 kPa dan tekanan pada B ialah 275 kPa. Kehilangan tenaga dalam sistem ialah 2.5 kali kelajuan kepala pada paip luahan. Kirakan kuasa yang dipindahkan dari pam ke minyak berkenaan.

(35 marks/*markah*)

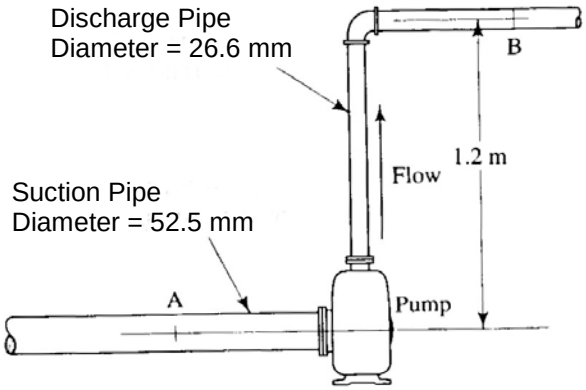

Figure 3

Rajah 3

[b] The setup shown in Figure 4 is being used to measure the energy loss across a valve. The velocity of the flow of oil is 1.2 m/s. Calculate the value of K if the energy loss is express as $K(v^2/2g)$.

Susunatur yang ditunjukkan pada Rajah 4 digunakan untuk mengukur kehilangan tenaga melalui suatu injap. Kelajuan aliran minyak ialah 1.2 m/s. Kirakan nilai K jika kehilangan tenaga diungkap sebagai $K(v^2/2g)$.

(30 marks/*markah*)

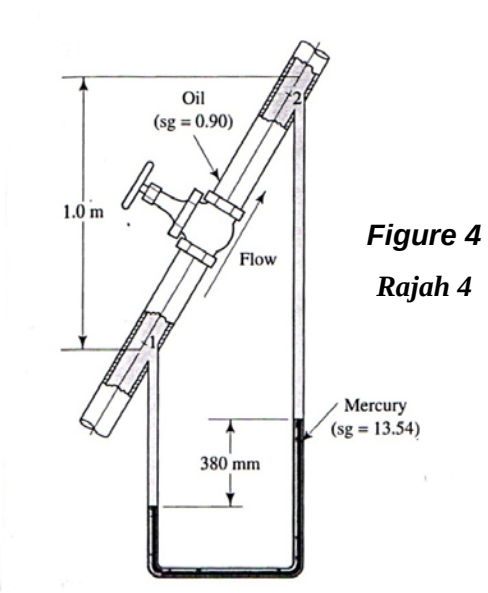

Figure 4

Rajah 4

(i) What is the rate of discharge of water over a 45^o triangular weir where the head is 1.83 m?

(ii) With the same head what would be the increase in discharge obtained by doubling the notch angle, i.e for a 90^o weir?

(iii) What would be the head for a discharge of 0.04 m^3/s over a 60^o triangular weir?

(i) Apakah kadar luahan air menerusi empang limpah segitiga 45^o *dimana turus adalah 1.83 m?*

(ii) Dengan ketinggian turus yang sama, apakah penambahan dalam buangan yang diperolehi dengan mengandakan sudut takuk,i.e untuk 90^o *empang?*

(iii) Apakan turus untuk buangan 0.04 m^3/s *melalui takuk segitiga* 60^oC*?*

(35 marks/*markah*)

3. [a] The pump in Figure 5 delivers water from the lower to the upper reservoir at the rate of 0.057m^3/s. The energy loss between the suction pipe inlet and the pump is 1.83 m and between the pump outlet and the upper reservoir is 3.66 m. Both pipes are 154.1 mm in diameter steel pipe. Calculate:

(i) the pressure at the pump inlet
(ii) the pressure at the pump outlet
(iii) the total head on the pump
(iv) the power delivered by the pump to the water

Sebuah pam yang ditunjukkan dalam Rajah 5 menghantar air dari empangan rendah ke empangan tinggi pada kadar 0.057m^3/s. Kehilangan tenaga antara salur masuk paip sedutan dan pam ialah 1.83 m dan antara salur keluar pam dengan empangan tinggi ialah 3.66 m. Kedua-dua paip keluli berdiameter 154.1 mm. Kirakan:

(i) tekanan pada salur masuk pam
(ii) tekanan pada salur keluar pam
(iii) jumlah turus pada pam
(iv) kuasa yang dihantar oleh pam ke air

(40 marks/*markah*)

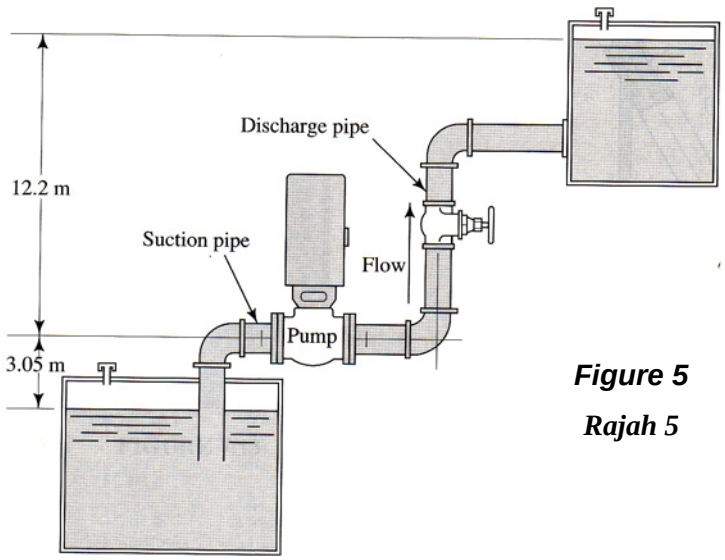

Figure 5
Rajah 5

[b] Water under a gage pressure of 350 kPa with a velocity of 5 m/s through a right-angled bend that has a uniform diameter of 250 mm. The bend lies in a horizontal plane, and water enters form the west and leaves toward the north. Assuming no drop in pressure, what is the magnitude and direction of the resultant force acting on the bend?

Air di bawah tekanan 350 kPa dan kelajuan 5 m/s melalui suatu bengkokan tegak berdiameter tetap 250 mm. Bengkokan tersebut berada pada satah ufuk dan air masuk dari barat dan keluar ke utara. Dengan anggapan tiada kejatuhan tekanan, apakah magnitud dan arah daya paduan yang dikenakan pada bengokkan tersebut?

(30 marks/*markah*)

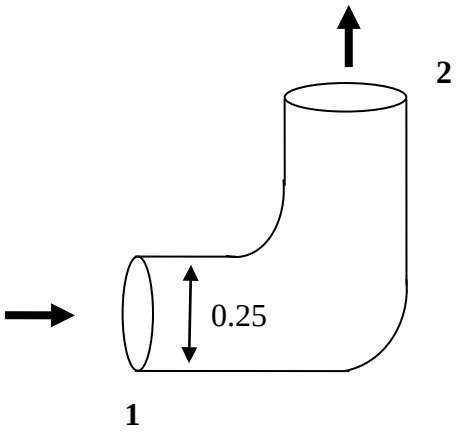

Figure 6

Rajah 6

[c] For the curve surface AB:

(i) determine the magnitude, direction, and line of action of the vertical component of the hydrostatic force acting on the surface. Here l = 1 m.

(ii) determine the magnitude, direction and line of action of the horizontal. component of hydrostatic force acting on the surface

(iii) determine the resultant hydrostatic force acting on the surface.

Untuk permukaan lengkungan AB:

(i) kirakan magnitud , arah dan garis bertindak bagi komponen tegak daya hidrostatik yang bertindak pada permukaan. Disini l = 1 m.

(ii) kirakan magnitud, arah dan garis bertindak bagi komponen ufuk daya hidrostatik yang bertindak pada permukaan.

(iii) kirakan daya hidrostatik paduan pada permukaan.

(35 marks/*markah*)

4. [a] Flow occurs over spillway of constant section as shown in Figure 7. Assuming ideal flow determine the resultant horizontal force on the spillway per meter of spillway width (perpendicular to spillway section), given that y_1 = 1.28 m and y_2 = 0.213 m. The spillway is 0.305 m wide.

Aliran terhasil di atas alur limpah malar seperti yang ditunjukkan pada Rajah 7. Anggap aliran ideal, tentukan daya ufuk paduan pada setiap meter lebar alur limpah (serenjang kepada bahagian alur limpah), diberi y_1 = 1.28 m dan y_2 = 0.213 m. Alir limpah mempunyai kelebaran 0.305 m.

(30 marks/*markah*)

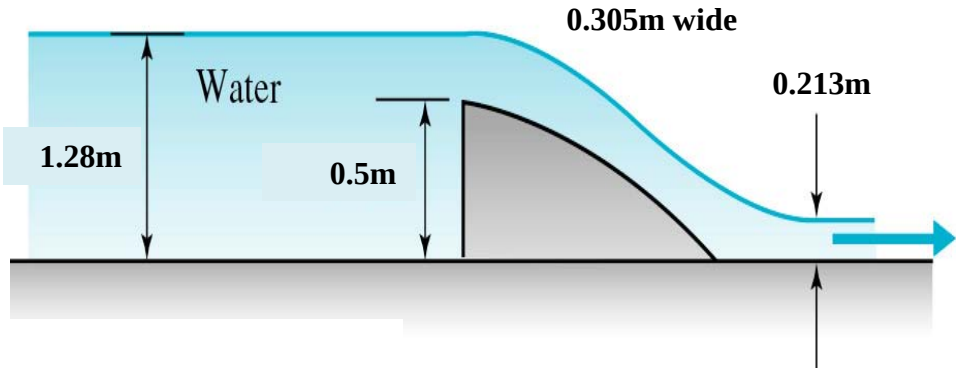

Figure 7

Rajah 7

[b] A vertical pipe of 1.5 m diameter and 20 m long has a pressure head of 6.3 m of water at its upper end. When the flow of water through it is such that the mean velocity is 5.65 m/s, the pipe friction is h_f = 1.09m. Find the pressure head at the lower end of the pipe when the flow is (a) downward; (b) upward.

Satu paip tegak berdiameter 1.5 m dan 20 m panjang mempunyai tekanan turus 6.3 m air pada atas (hujungnya). Apabila aliran air mempunyai kelajuan min 5.65 m/s, geseran paip ialah h_f = 1.09 m. Dapatkan tekanan turus pada bahagian hilir (bawah) paip apabila aliran adalah (a) ke bawah (b) ke atas.

(35 marks/*markah*)

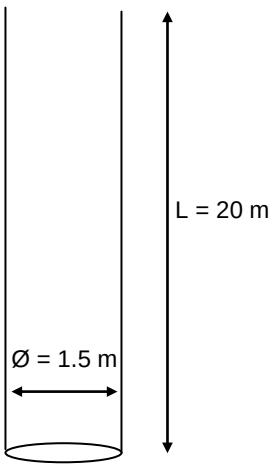

Figure 8

Rajah 8

[c] Water flow through a pipe at 0.4 m^3s. At a point where the pipe is 5.5 cm, the pressure is 207 kPa; at second point, further along the flow path and 0.61 m lower than the first, the diameter is 2.74 cm and the pressure is 124.1 kPa. Find the pipe friction head loss between the two points. Neglect other head losses.

Air mengalir melalui paip pada 0.4 m^3s. Pada titik di mana diameter paip adalah 5.5 cm, tekanan ialah 207 kPa; pada titik kedua yang berada 0.61 m di bawah titik pertama, diameter adalah 2.74 cm dan tekanan ialah 124.1 kPa. Kirakan kehilangan turus geseran paip antara kedua-dua titik tersebut. Abaikan kehilangan turus yang lain.

(30 marks/*markah*)

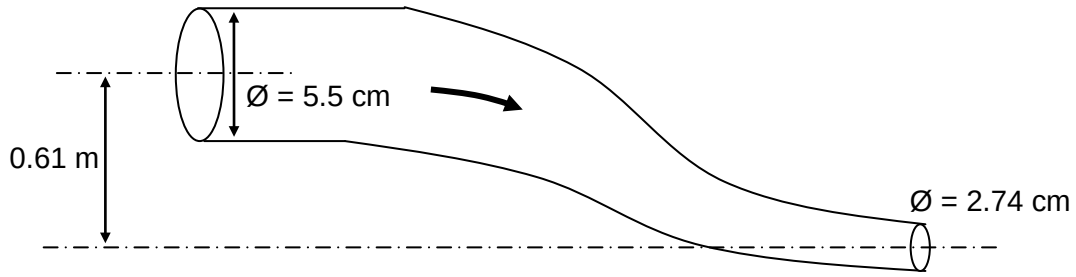

Figure 9

Rajah 9

PART B

BAHAGIAN B

5. Derive head loss due to friction (Eq. 1).

Terbitkan kehilangan tenaga disebabkam geseran (Eq. 1).

$$h_f = \frac{4\tau_w}{\rho g}\frac{L}{d} \qquad \text{(Eq. 1)}$$

from Incompressible Steady Flow Energy Equation (Eq. 2)

daripada persamaan tenaga pengaliran mantap tak termampat (Eq. 2)

$$\left(\frac{p}{\rho g}+\alpha\frac{V^2}{2g}+z\right)_1=\left(\frac{p}{\rho g}+\alpha\frac{V^2}{2g}+z\right)_2+h_{turbine}-h_{pump}+h_{friction} \qquad \text{(Eq. 2)}$$

with the Figure 10 below:

dengan Rajah 10 di bawah:

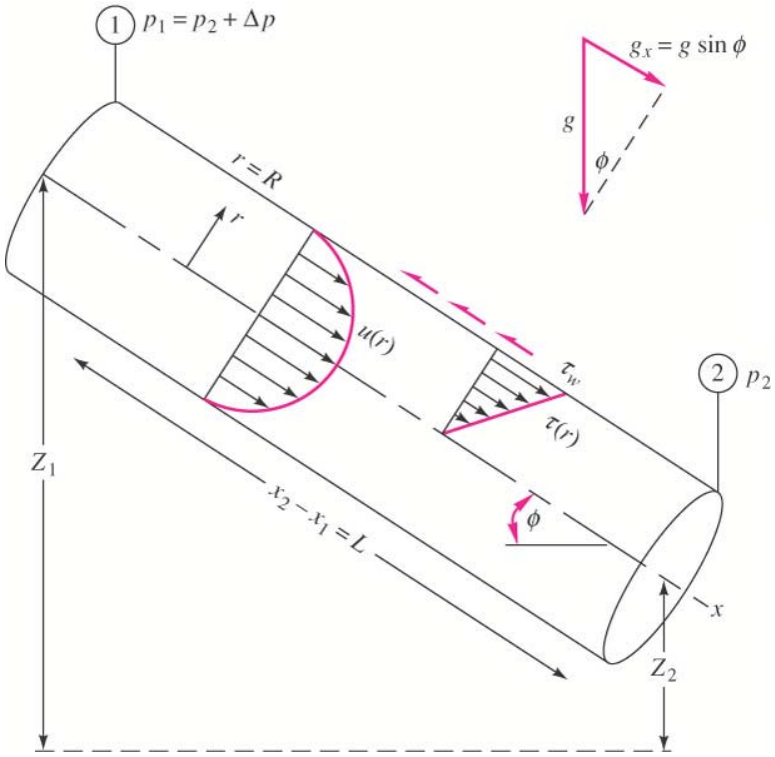

Figure 10

Rajah 10

Assuming $\sum_i Q_{in} = \sum_i Q_{out}$

Anggapkan

(100 marks/*markah*)

6. [a] Name the 4 combinations of free-surface flow classification.

Namakan 4 klasifikasi aliran permukaan bebas.

(20 marks/*markah*)

[b] A channel cross section, commonly called a gutter, forms at the side of a street next to a curb during rainfall conditions. The slope along the roadway is S_0 = 0.0005, the manning coefficient is given as n = 0.015. Assuming that uniform flow conditions occur:

(i) Determine the discharge if the depth of flow is y_0 = 12 cm.

(ii) If Q = 80 L/s, what is the flow depth y_0?

Keratan rentas bagi saliran, atau longkang, terbentuk di tepi jalan sebelah batas semasa hujan. Kecerunannya sepanjang jalan adalah S_0 = 0.0005, pemalar manning diberi sebagai n = 0.015. Andaikan aliran seragam berlaku:

(i) Hitungkan discaj jika kedalaman aliran y_0 = 12 cm.

(ii) Jika Q = 80 L/s, apakah kedalaman aliran y_0?

(80 marks/*markah*)

Figure 11

Rajah 11

7. Gasoline is being pumped at 400 L/s in a pipeline from location A to B as shown in Figure 12. The pipe follows the topology as shown, with the highest elevation shown at location C. The only contributions to minor losses are the two valves located at the ends of the pipe. If γ = S = 0.81, v= 4.26 x 10^{-7} m^2/s, p_v = 55.2 kPa absolute and p_{atm} = 100 kPa,

Gasolin dipam pada 400 L/s dalam lingkaran paip dari lokasi A ke B seperti ditunjukkan dalam Rajah 12. Paip didapati mengikut topologi seperti ditunjukkan, dengan ketinggian tertinggi di lokasi C. Kehilangan minor yang hanya didapati adalah 2 valve pada hujung paip. Jika $\gamma = S = 0.81$, $v = 4.26 \times 10^{-7}$ m^2/s, $p_v = 55.2$ *kPa absolute dan* $p_{atm} = 100$ *kPa,*

(i) Determine the necessary power to be delivered to the system to meet the flow requirement.

Hitungkan kuasa yang perlu dihantar ke sistem untuk memenuhi keperluan aliran.

(65 marks/*markah*)

(ii) What is the maximum elevation possible at location C without causing vapor pressure conditions to exist?

Ketinggian maksimum yang mungkin pada lokasi C tanpa menyebabkan kewujudan syarat tekanan wap.

(35 marks/*markah*)

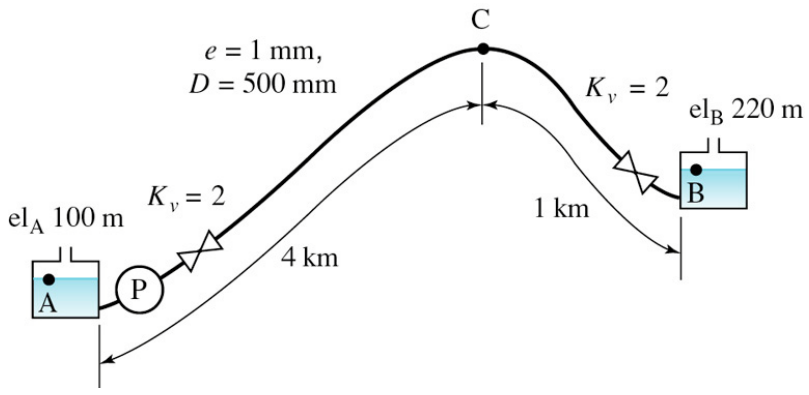

Figure 12

Rajah 12

- oooOooo -

APPENDIX 1

LAMPIRAN 1

TABLE B.5 Properties of Common Liquids at Atmospheric Pressure and Approximately 60 to 70°F (16 to 21°C)

	Specific weight γ		*Density* ρ		*Surface tension*[a] σ		*Vapor pressure* p_v	
Liquid	lb/ft^3	N/m^3	$slugs/ft^3$	kg/m^3	lb/ft	N/m	psia	kPa
Alcohol, ethyl	49.3	7 744	1.53	789	0.0015	0.022	—	—
Benzene	56.2	8 828	1.75	902	0.0020	0.029	1.50	10.3
Carbon tetrachloride	99.5	15 629	3.09	1 593	0.0018	0.026	12.50	86.2
Gasoline	42.4	6 660	1.32	680	—	—	—	—
Glycerin	78.6	12 346	2.44	1 258	0.0043	0.063	2×10^{-6}	1.4×10^{-5}
Kerosene	50.5	7 933	1.57	809	0.0017	0.025	—	—
Mercury	845.5	132 800	26.29	13 550	0.032	0.467	2.31×10^{-5}	1.59×10
SAE 10 oil	57.4	9 016	1.78	917	0.0025	0.036	—	—
SAE 30 oil	57.4	9 016	1.78	917	0.0024	0.035	—	—
Turpentine	54.3	8 529	1.69	871	0.0018	0.026	7.7×10^{-3}	5.31×10^{-2}
Water	62.4	9 810	1.94	1000	0.0050	0.073	0.34	2.34

[a]In contact with air.

Properties of Common Liquids at Atmospheric Pressure and Approximately 16^0 to 21^0C

Sifat-Sifat Bendalir Biasa padaTekanan Atmosfera dan Suhu anggaram 16^0 to 21^0C

APPENDIX 2

LAMPIRAN 2

Material	Roughness ϵ (m)	Roughness ϵ (ft)
Glass	Smooth	Smooth
Plastic	3.0×10^{-7}	1.0×10^{-6}
Drawn tubing; copper, brass, steel	1.5×10^{-6}	5.0×10^{-6}
Steel, commercial or welded	4.6×10^{-5}	1.5×10^{-4}
Galvanized iron	1.5×10^{-4}	5.0×10^{-4}
Ductile iron—coated	1.2×10^{-4}	4.0×10^{-4}
Ductile iron—uncoated	2.4×10^{-4}	8.0×10^{-4}
Concrete, well made	1.2×10^{-4}	4.0×10^{-4}
Riveted steel	1.8×10^{-3}	6.0×10^{-3}